Effect of ocean temperature on southwestern U.S. climate analyzed

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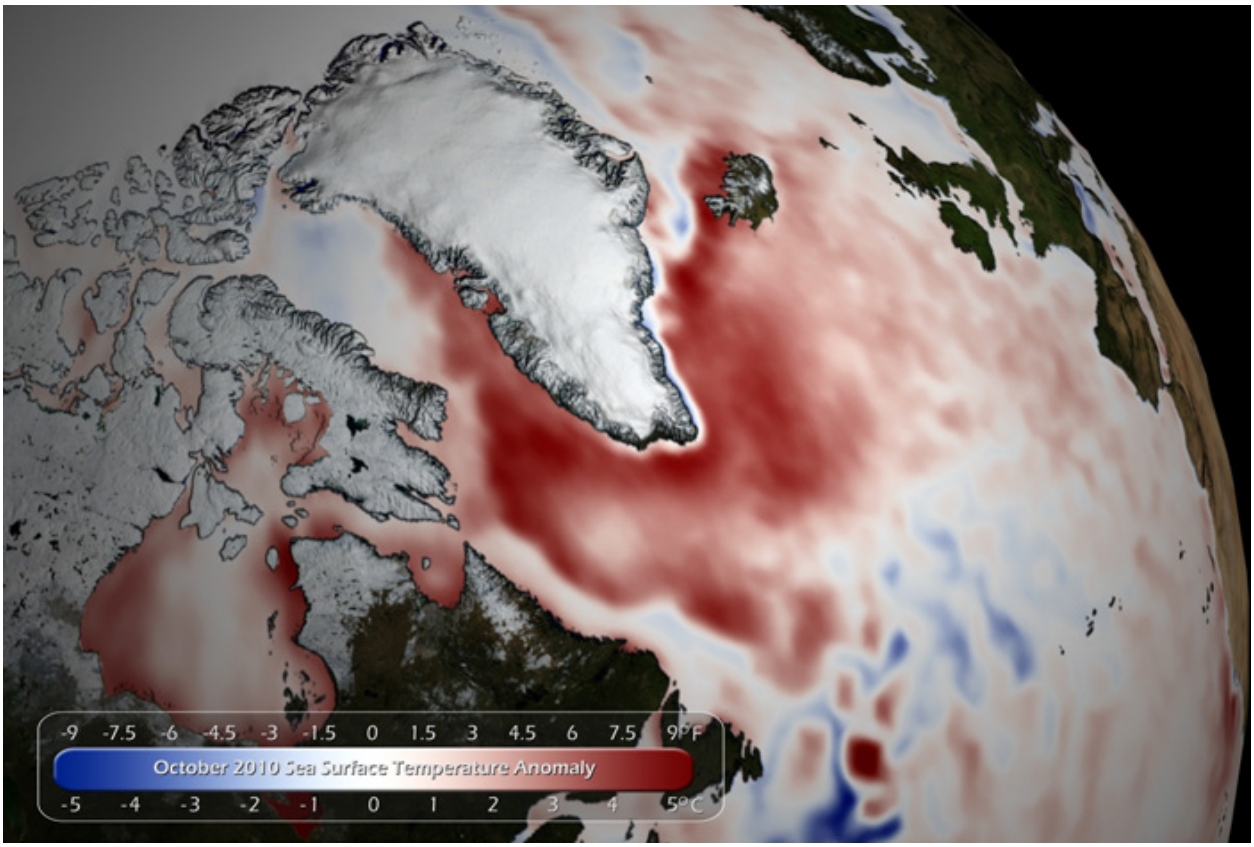

Researchers have analyzed the relationship between a natural phenomenon in the North Atlantic and the temperature and precipitation patterns in the American Southwest. They concluded that only part of the recent temperature rise in the Southwest could be attributed to greenhouse gases. A significant amount of the increase is tied to the cyclic pattern of the Atlantic multi-decadal oscillation (AMO), a manifestation of the global ocean circulation pattern. Assuming that the past is a good indicator of the future, the scientists conclude that there should be wetter times ahead. The journal Climate Dynamics reported the findings.

Significance of the research

The scientists analyzed more than 100 years of temperature and precipitation data for the Southwest to understand how they relate to the cyclic pattern of the Atlantic multi-decadal oscillation, observed in the sea-surface temperatures of the North Atlantic. Data

stretching back 1,000 years shows that the AMO cycles through cooler and warmer phases about every 70 years, with some variability in the timing. The AMO has been tied to variations in temperature and precipitation in a number of parts of the globe.

The results from the historical analysis differ from other scientists' predictions of an imminent transition in the Southwest to a more arid climate. Those predictions are made by global climate models, which generally do not include effects from phenomena such as the AMO. The researchers suggest that most climate models significantly overestimate the sensitivity of temperature in the Southwest to greenhouse gas contributions. Based upon their analysis of past trends, the team projected future trends to the year 2050. They concluded that temperature in the Southwest would stay constant at about its current value while rainfall would diminish for the next few years and then increase.

Research achievements

Petr Chylek of LANL's Space and Remote Sensing group led the scientists to perform multiple linear regression analysis of surface air temperature and precipitation records provided by the National Oceanic and Atmospheric Administration (NOAA) National Climate Data Center. The analysis assumed historical radiative forcing (such as greenhouse gases, anthropogenic aerosols, solar irradiance, volcanic aerosols, and the El Niño Southern Oscillation) and natural variability (such as the AMO and the Pacific decadal oscillation, or PDO) as predictors for temperature and precipitation trends. The archived data reveal a general trend toward a warmer climate but with a nearly unchanged rate of precipitation over the past 118 years.

The analysis showed that a warming trend in the Southwest from 1915 to 1935 and a subsequent cooling period from 1955 to 1975 was dominated by the AMO with only minor contributions from greenhouse gases and solar irradiance. The post-1975 warming trend is about equally split between AMO and greenhouse gases.

Similarly, the analysis for precipitation data showed that greenhouse gases and aerosols had essentially no correlation with precipitation in the Southwest, whereas the AMO and PDO did. The drought during the early 1950s was related to a rapid decrease of the PDO, and the current drought is associated with both the PDO and AMO being near their minimum values.

The researchers used the linear regression analysis to predict future trends in temperature and precipitation for the Southwest. Assuming that the AMO behaves as it has historically, the analysis indicated that the temperature in the Southwest to the year 2050 would stay constant at about its current value while rainfall would remain diminished for the next few years and then increase over the following several decades.

The research team

The Los Alamos authors include Chylek, Manvendra Dubey of Earth System Observations, Nick Hengartner of Theoretical Biology and Biophysics, G. Lesins of Dalhousie University and J. Li of the Canadian Centre for Climate Modeling and Analysis.

LANL's Institute for Geophysics, Planetary Physics, and Signatures sponsored the research. The work supports the Lab's Energy Security mission area and the Science of Signatures and the Information, Science, and Technology science pillars.

Photo caption for image below: Regression model projection of the future southwestern U.S. temperature and precipitation for the case of the AMO repeating its 20th century

cycle (blue curve) and for a very unlikely case of the AMO continuing its post 1975 rising trend (red curve).